French Patent Application No: 2 724 388
Date of application: 13.09.94
Date of publication: 15.03.96
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Process and thermoplastic compositions for producing water-soluble and biodegradable containers and the containers obtained

Abstract: A process and thermoplastic compositions for producing water-soluble and biodegradable containers such as bottles, flasks or drums, in particular those intended to contain noxious, toxic or dangerous products.

According to the invention:

a) a polyvinyl alcohol with a sodium acetate concentration of at most 0.5 wt.% and a degree of hydrolysis which is between 80% and 92% is chosen;

b) at least one plasticiser is added thereto; and

c) the mixture is homogenised in order to obtain

. a moisture content of less than or equal to 0.5% at 200°C and less than or equal to 0.1% at 120°C; and

. virtually zero concentration of non-molten material.

The present invention relates to a process and thermoplastic compositions for producing containers such as bottles, flasks, drums, etc. intended to contain products which are noxious, toxic or dangerous, in particular for the environment, said containers having to be water-soluble and biodegradable. It also relates to the containers obtained by using the process and thermoplastic compositions according to the present invention.

It is known that polyvinyl alcohols have specific properties which enable the production, starting from sheets or films made of these materials, of bags or sachets which are soluble in cold or hot water, are biodegradable, are impenetrable by odours, gases and ultraviolet radiation and are resistant to oils and aliphatic and aromatic hydrocarbons. These bags or sachets are thus advantageous with regard to their use as packaging. However, they have the disadvantage of having only low mechanical strength, so they can easily be torn, which makes them virtually unusable, as such, for the packaging of noxious, toxic and/or dangerous products.

The object of the present invention is to remedy this disadvantage and to produce a container such as a bottle, flask, can, etc., which is sufficiently mechanically strong to enable it to contain a toxic, noxious and/or dangerous product, with no possibility of tearing, said container having to be soluble in cold and hot water, biodegradable and comply with the requirements for storage and transport of said product, this product being in the solid, liquid or gel form.

For this purpose, according to the invention, the process for producing containers such as bottles, flasks or drums, in particular those intended to contain noxious, toxic or dangerous products, said containers having to be water-soluble and biodegradable, is characterised in that:

a) a polyvinyl alcohol with a sodium acetate concentration of at most 0.5 wt.% and a degree of hydrolysis of between 80% and 92% is chosen as the base material for producing the said containers;
b) an intermediate thermoplastic composition is formed by adding at least one plasticiser to said base polyvinyl alcohol, in the proportion of 13 wt.% to 20 wt.%, with respect to said intermediate thermoplastic composition;
c) said intermediate thermoplastic composition is homogenised by introducing an energy of

at least 0.5 kW/h/kg thereto and the temperature of said intermediate thermoplastic composition is maintained at a value below 230°C, in such a way as to obtain a homogenised thermoplastic composition:

- with a moisture content, measured by the Karl Fischer method (standard NFT 20-052), which is less than or equal to 0.5 % at 200°C and less than or equal to 0.1% at 120°C; and
- with a concentration of non-molten material which is such that, if said homogenised thermoplastic composition is used to form a film with a thickness of 100 μm, 10 m^2 of such a film will contain less than nine non-molten specks with sizes between 150 and 200 μm and will not contain any non-molten speck at all with a size greater than 200 μm; and

d) said homogenised thermoplastic composition is used to manufacture said containers by employing a known process.

Thus, as a result of the present invention, containers can be obtained which are resistant to cold and to shock, to handling and to storage, without imperfections and with homogeneous and regular physico-chemical properties and which can be manufactured by employing the known processes of extrusion blow-moulding or injection moulding.

The containers according to the invention satisfy the known mechanical resistance tests. For example, with regard to resistance to cold, the test consists of maintaining such a container, containing the noxious, toxic or dangerous product, at a temperature of -18°C for a minimum of 48 hours, then subjecting it to successive drops on the small and large faces and on the angles, with drop-heights varying between 1.2 m and 1.8 m, depending on the toxicity of the product contained in the container.

The toxic, noxious and/or dangerous products may be in the solid form (such as powders, granules, etc.), in the liquid form or in the form of a gel. In these latter two cases, it is advantageous if the concentration of free water in said products is less than 5 wt.%, in order to avoid an attack on said containers by the water contained in said products.

After using the toxic, noxious and/or dangerous product contained in a container according to

the present invention, said empty and contaminated container can easily be disposed of by dissolution in water. If said product is itself used after dissolution, suspension or dispersion in water, said empty and contaminated container may be dissolved in the aqueous mass of said product in order to be disposed of during the course of use of the product which it once contained. Otherwise, the water containing the dissolved container must be sent to a water purification station.

By way of illustrative and non-restrictive examples, two important uses for containers according to the invention are outlined below:

A) It is known that insecticides are toxic or noxious products and that the most common form of presentation of these is in the form of a concentrated and emulsified organic-based liquid. When they are used, they are poured into an application reservoir containing water and the aqueous emulsion thus obtained is sprayed out. If said insecticides are packed in containers according to the present invention, once emptied of their contents, these contaminated containers are easily disposed of by immersion, either directly in said application reservoir for said insecticides or in an auxiliary tank containing water, the contents of which, after dissolution of said containers, is poured into said application reservoir. Whichever of these modes of operation is used, it can be seen that the contaminated containers are disposed of during use of the products which they once contained.

   It goes without saying, that such a process can be used with any plant protection product at all (fungicide, insecticide, herbicide, etc.) which is presented in the form of an organic-based liquid or in the form of a gel.

B) Herbicides in the form of granules for the protection of crops are very often packaged in polyethylene or propylene packaging. This packaging, in the form of bottles or drums, after use of the product, is considered to be contaminated packaging which has to be rinsed, collected and decontaminated.

   Thus, it can be seen from the preceding that it is advantageous to replace this known packaging with containers according to the present invention, which can be disposed of in

a manner which respects the environment, as described in the preceding example, after use of the herbicides. In this way, any risk associated with inadequate decontamination, or an accidental leakage, during the course of transport of the soiled packaging, of residues of dangerous products, is eliminated. Moreover, all the costs associated with the recovery and decontamination of the packaging are also eliminated.

In a more general manner, plant protection products (fungicides, insecticides, herbicides, etc.) in the form of granules, detergents, disinfectants and oils may be packed, with the advantages described above, in containers according to the present invention.

When performing the process according to the present invention, an intermediate thermoplastic composition is first produced (generally called a "formulation" in the thermoplastic materials industry), after which a homogenised thermoplastic composition is manufactured (generally called a "compound" or "blend" in the thermoplastics materials industry).

Said intermediate thermoplastic composition is then characterised in that it contains, as base material, a polyvinyl alcohol with a sodium acetate concentration of at most 0.5 wt.% and has a degree of hydrolysis of between 80% and 92%, said polyvinyl alcohol containing at least one added plasticiser in the proportion of 13 to 20 wt.%, with respect to said intermediate thermoplastic composition.

Due to the homogenisation of said intermediate thermoplastic composition in the way described in stage c) of the process, a homogenised thermoplastic composition is then obtained which is characterised in that:

- it contains, as base material, a polyvinyl alcohol with a concentration of sodium acetate of at most 0.5 wt.% and with a degree of hydrolysis of between 80% and 92%, said polyvinyl alcohol being supplemented by at least one plasticiser in the proportion of 13 to 20 wt.% of said composition;
- the moisture content of said homogenised thermoplastic composition, measured by the Karl Fischer method (standard NFT 20-052), is less than or equal to 0.5 % at 200°C and less than or equal to 0.1% at 120°C; and
- the amount of non-molten material in said homogenised thermoplastic composition is such

that, if it were used to form a film with a thickness of 100 μm, 10 m^2 of such a film would contain less than nine non-molten specks with a size between 150 and 200 μm and would not contain any non-molten specks with a size greater than 200 μm.

Such a homogenised thermoplastic composition, which is provided for example in the form of granules, is then directly useable for manufacturing said containers, for example by extrusion blow-moulding or injection moulding.

It is known that sodium acetate is a normal impurity in polyvinyl alcohols. Thus, according to the present invention, a polyvinyl alcohol of high purity with a concentration of less than 0.5 wt.% or even, preferably, less than 0.3 wt.% of sodium acetate is chosen. Thus, high quality intermediate and homogenised thermoplastic compositions are obtained which are likely to produce final containers without imperfections and with uniform physico-chemical properties, homogenisation not requiring the input of an amount of energy and/or a temperature which is likely to initiate decomposition of the polyvinyl alcohol. In fact, sodium acetate modifies the pH of polyvinyl alcohol and has a catalytic effect by accelerating decomposition of the latter at temperatures above 180°C. The low concentration of sodium acetate of the chosen polyvinyl alcohol permits the production of a raw material with a neutral to slightly acid pH which is particularly stable at the temperatures used during homogenisation.

Moreover, it is known that polyvinyl alcohols are obtained by the polymerisation of vinyl acetate and partial or complete hydrolysis. The hydrolysis process consists of substituting, in a polyvinyl alcohol, carbonyl radicals by hydroxyl radicals, the degree of hydrolysis being equal to the percentage to which such a substitution takes place and being representative of the solubility of said polyvinyl alcohols in water. According to the invention, a degree of hydrolysis between 80% and 92% is chosen in such a way as to obtain containers which are readily soluble in cold water.

Experience has shown that, in order to obtain good cold and shock resistant properties, a plasticiser has to be added in the proportion of 13 to 20 wt.%, preferably 15 to 17 wt.% with respect to the intermediate thermoplastic composition.

Such a concentration of plasticiser may be obtained using a single plasticising agent.

However, it has been confirmed that it is often preferable to use several plasticising agents in combination in order to obtain better mechanical strength in the cold.

The plasticising agent(s) used are from the glycol family.

Preferably, said plasticiser consists of glycerol, the concentration of glycerol being at least 10 wt.% with respect to the intermediate thermoplastic composition, and/or triethylene glycol, the concentration of triethylene glycol being at least 3 wt.% with respect to said intermediate thermoplastic composition, and/or polyethylene glycol with a molecular weight between 200 and 400, the concentration of polyethylene glycol being at least 3 wt.%, with respect to the intermediate thermoplastic composition.

In order to enable adequate processability of said homogenised thermoplastic composition, with the intention of manufacturing said containers, this composition must have appropriate rheological properties.

To this end, in the event that said homogenised thermoplastic composition is intended for the manufacture of said containers by using an extrusion blow-moulding process, it is advantageous that:

- the melt flow index, MFI, determined in accordance with the standard NFT 51-016, is between 1 and 10 g/10 min, at a temperature of 230°C under the effect of a weight of 2.16 kg; and
- the viscosity at 20°C of the base polyvinyl alcohol, determined in accordance with the standards DIN 51-550 and DIN 1342, is between 8 and 40 mPa.s, preferably between 8 and 26 mPa.s.

On the other hand, in the event that said homogenised thermoplastic composition is intended for the manufacture of said containers by using an injection moulding process, it is advantageous that:

- the melt flow index, MFI, determined in accordance with the standard NFT 51-016, is between 10 and 30 g/10 min, at a temperature of 190°C under the effect of a weight of 2.16 kg; and
- the viscosity at 20°C of the base polyvinyl alcohol, determined in accordance with the

standards DIN 51-550 and DIN 1342, is between 3 and 8 mPa.s, preferably between 3 and 5 mPa.s.

In fact, for extrusion blow-moulding, it is advantageous to use polyvinyl alcohols with a long molecular chain, thus with high viscosities. For injection moulding, on the other hand, short molecular chain polyvinyl alcohols, with a low viscosity, are advantageously used in order for said homogenised thermoplastic composition to be sufficiently fluid to be able to be easily injected into and completely fill the moulds, even when they have complex shapes.

A few examples of the intermediate thermoplastic composition according to the present invention are given below.

Example 1:

This example relates to an intermediate thermoplastic composition intended for an injection moulding process for manufacturing containers which are soluble in cold water:

- polyvinyl alcohol containing at most 0.3 wt.% of sodium acetate, with a degree of hydrolysis of 88% and having a viscosity at 20°C of 4 mPa.s — 100 parts by wt.
- glycerol — 12 parts by wt.
- triethylene glycol — 4 parts by wt.
- glycerol monostearate — 1.5 parts by wt.

In this composition, the glycerol and triethylene glycol form the plasticiser, whereas the glycerol monostearate is a mould release agent which prevents the mixture sticking to the walls of the mould.

Example 2:

This example is also intended for the manufacture, by an injection moulding process, of containers which are soluble in cold water:

- polyvinyl alcohol containing at most 0.3 wt.% of sodium acetate, with a degree of hydrolysis of 83%

and having a viscosity at 20°C of 3 mPa.s	100 parts by wt.
- glycerol	15 parts by wt.
- polyethylene glycol (PEG 300)	4 parts by wt.
- glycerol monostearate	1 part by wt.

As compared with example 1, the proportions of glycerol and glycerol monostearate have been modified and triethylene glycol has been replaced by polyethylene glycol.

Example 3:

This composition is intended for manufacturing containers which are soluble in cold water, by using an extrusion blow-moulding process:

- polyvinyl alcohol containing at most 0.3 wt.% of sodium acetate, with a degree of hydrolysis of 88% and having a viscosity at 20°C of 18 mPa.s	100 parts by wt.
- glycerol	15 parts by wt.
- a homopolymer of polyvinyl alcohol	2.5 parts by wt.
- stearic acid	0.2 parts by wt.

In this example, the last two components form an antiblocking agent.

Example 4:

A composition also intended for manufacturing containers which are soluble in cold water and using an extrusion blow-moulding process:

- polyvinyl alcohol containing at most 0.3 wt.% of sodium acetate, with a degree of hydrolysis of 88% and having a viscosity at 20°C of 8 mPa.s	100 parts by wt.
- glycerol	15 parts by wt.
- triethylene glycol	4 parts by wt.
- glycerol monostearate	1 parts by wt.

The quality of the final containers depends closely on the quality of the thermoplastic

composition. If this latter is perfectly homogeneous and does not include any non-molten material, containers in accordance with the invention will have no imperfections and will have uniform physico-chemical properties. It should be mentioned here that, in a manner which is conventional in thermoplastic engineering, the word "non-molten material" means small lumps of matter from the intermediate thermoplastic composition ("formulation") which have not melted and form heterogeneities in the homogenised thermoplastic composition ("compound" or "blend").

In order to obtain good homogenisation of the intermediate thermoplastic composition (an operation generally called "compounding" in this industrial sector), it is advantageous to use a co-rotating, twin-screw extruder. The mixing and compounding process can then be perfectly controlled by combining shearing energy and thermal energy. This type of extruder also enables the incorporation of components at different positions along the extruder, and also the release of vapours. Thus, in the first section of the extruder (upstream end), only the solid components are introduced in order to apply large shear forces to them, while liquid components, which generally reduce these forces, are introduced only in subsequent sections of the extruder.

Water which is present in the raw materials is eliminated by degassing before the last section of the extruder (downstream end) in order to achieve the moisture content specified below.

Thus, a homogenised thermoplastic composition is obtained, for example in the form of granules, which contains virtually no non-molten material, these having been broken up, melted and dispersed due to the application of shear forces. In that way, the temperature applied to the thermoplastic material, regulated in each section of the extruder, may remain lower than 230°C (or even lower than 220°C), which is guarantee that the polyvinyl alcohol does not decompose.

Thus, during the homogenisation stage:

- the intermediate thermoplastic composition is mixed and homogenised while avoiding thermal decomposition of the polyvinyl alcohol. For this to happen, the total energy input by the extruder (mechanical energy + thermal energy) is greater than or equal to 0.5 kW/h/kg, preferably between 0.5 and 1.2 kW/h/kg, and the temperature along the

extruder is kept between 140°C and 230°C, preferably between 160°C and 220°C; and

- a homogenised thermoplastic composition is produced:
  - with a moisture content, measured by the Karl Fischer method (standard NFT 20-052), which is less than or equal to 0.5% at 200°C and less than or equal to 0.1% at 120°C; and
  - with an amount of non-molten material such that, if said homogenised thermoplastic composition were used to form a film with a thickness of 100 μm, 10 m^2 of such a film would contain less than nine non-molten specks with a size between 150 and 200 μm and would not include any non-molten specks with a size greater than 200 μm.

From the above, it is obvious that, by using the process and the intermediate and homogenised thermoplastic compositions, containers which are made from a homogeneous material, are water-soluble and biodegradable and are based on polyvinyl alcohol can be readily obtained, for example, by the extrusion blow-moulding or injection moulding of said homogenised thermoplastic composition.

It should be noted that said process and said thermoplastic compositions according to the present invention are not restricted to the manufacture of homogeneous containers, but, on the contrary, may be used to produce composite containers with an external envelope, made from any material desired (for example polyethylene) and an internal envelope, adjacent to said external envelope and produced from the homogenised thermoplastic composition according to the present invention. Such a container may be produced, for example, by co-extrusion of said thermoplastic for the external envelope and said homogenised thermoplastic composition, and blow-moulding.

Such a composite container could than have the combined advantages due to the two materials involved. In fact, if said external envelope is made of polyethylene terephthalate, it would provide an excellent moisture barrier and give good mechanical strength to said composite container, while the internal envelope, made according to the invention, provides the properties of solubility and biodegradability mentioned above.

Thus, this type of composite container might be used to store and transport toxic or noxious and/or environmentally dangerous (insecticide) products which are particularly sensitive to

moisture and/or require high-level safety conditions during the course of transport and storage. After using such a product, the internal envelope could be disposed of by dissolution in water (as indicated above), in such a way that said container, reduced to only its external envelope, is cleansed of any trace of the product in complete safety and it would be possible to recover a non-contaminated package for recycling.

CLAIMS

1. A process for producing containers such as bottles, flasks or drums, in particular those intended to contain noxious, toxic or dangerous products, said containers having to be water-soluble and biodegradable characterised in that:

   a) a polyvinyl alcohol with a sodium acetate concentration of at most 0.5 wt.% and a degree of hydrolysis of between 80% and 92% is chosen as the base material for producing such containers;

   b) an intermediate thermoplastic composition is formed by adding at least one plasticiser to said base polyvinyl alcohol, in the proportion of 13 wt.% to 20 wt.%, with respect to said intermediate thermoplastic composition;

   c) said intermediate thermoplastic composition is homogenised by introducing an energy of at least 0.5 kW/h/kg thereto and maintaining the temperature of said intermediate thermoplastic composition at a value below 230°C, in such a way as to obtain a homogenised thermoplastic composition:

      - with a moisture content, measured by the Karl Fischer method (standard NFT 20-052), which is less than or equal to 0.5 % at 200°C and less than or equal to 0.1% at 120°C; and
      - with a concentration of non-molten material which is such that, if said homogenised thermoplastic composition is used to form a film with a thickness of 100 μm, 10 m^2 of such a film will contain less than nine non-molten specks with sizes between 150 and 200 μm and will not contain any non-molten speck at all with a size greater than 200 μm; and

   d) said homogenised thermoplastic composition is used to manufacture said containers by employing a known process.

2. A process according to Claim 1, in which the manufacture of said containers from said homogenised thermoplastic composition is obtained by using an extrusion blow-moulding process, characterised in that the melt flow index MFI of said homogenised thermoplastic composition, determined according to the standard NF 51-016, is between 1 and 10 g/10 min, at a temperature of 230°C under the effect of a weight of 2.16 kg.

3. A process according to Claim 1, in which the manufacture of said containers from said homogenised thermoplastic composition is obtained by using an injection moulding process, characterised in that the melt flow index MFI of said homogenised thermoplastic composition, determined according to the standard NF 51-016, is between 10 and 30 g/10 min, at a temperature of 190°C under the effect of a weight of 2.16 kg.

4. A process according to any one of Claims 1 to 3, characterised in that the concentration of sodium acetate in the base material polyvinyl alcohol is at most 0.3 wt.%.

5. A process according to any one of Claims 1 to 4, characterised in that the concentration of plasticiser is between 15 and 17 wt.%, with respect to the intermediate thermoplastic composition.

6. A process according to any one of Claims 1 to 5, characterised in that said plasticiser contains glycerol, the concentration of glycerol being at least 10 wt.%, with respect to the intermediate thermoplastic composition.

7. A process according to any one of Claims 1 to 6, characterised in that said plasticiser contains triethylene glycol, the concentration of triethylene glycol being at least 3 wt.%, with respect to the intermediate thermoplastic composition.

8. A process according to any one of Claims 1 to 7, characterised in that said plasticiser contains polyethylene glycol with a molecular weight between 200 and 400, the concentration of polyethylene glycol being at least 3 wt.%, with respect to the intermediate thermoplastic composition.

9. A process according to any one of Claims 1 to 8, characterised in that the total energy input to said thermoplastic composition during the homogenisation stage is between 0.5 and 1.2 kW/h/kg.

10. A process according to any one of Claims 1 to 9, characterised in that, during the homogenisation phase, the temperature of the thermoplastic composition is at most 220°C.

11. A process according to any one of Claims 1 to 9, characterised in that the homogenisation phase for the composition is performed in a twin-screw extruder and in that the temperature profile inside said extruder is between 140°C and 230°C.

12. A process according to any one of Claims 10 and 11, characterised in that the temperature profile inside said screw extruder is between 160°C and 220°C.

13. An intermediate thermoplastic composition for making containers such as bottles, flasks or drums, in particular those intended to contain noxious, toxic or dangerous products, said containers having to be water-soluble and biodegradable, characterised in that it contains, as the base material, a polyvinyl alcohol with a concentration of sodium acetate of at most 0.5 wt.% and with a degree of hydrolysis between 80% and 92%, said polyvinyl alcohol being supplemented by at least one plasticiser in the proportion of 13 to 20 wt.%, with respect to said intermediate thermoplastic composition.

14. An intermediate thermoplastic composition according to Claim 13, characterised in that the concentration of sodium acetate in the base polyvinyl alcohol is at most 0.3 wt.%.

15. An intermediate thermoplastic composition according to one of Claims 13 or 14, characterised in that the concentration of plasticiser is between 15 and 17 wt.%, with respect to said composition.

16. An intermediate thermoplastic composition according to any one of Claims 13 to 15, characterised in that said plasticiser contains glycerol, the concentration of glycerol being at least 10 wt.%, with respect to said composition.

17. An intermediate thermoplastic composition according to any one of Claims 13 to 16,

characterised in that said plasticiser contains triethylene glycol, the concentration of triethylene glycol being at least 3 wt.%, with respect to said composition.

18. An intermediate thermoplastic composition according to any one of Claims 13 to 17, characterised in that said plasticiser contains polyethylene glycol with a molecular weight between 200 to 400, the concentration of polyethylene glycol being at least 3 wt.%, with respect to said composition.

19. A homogenised thermoplastic composition, ready to make, by using a known method of manufacture, containers such as bottles, flasks or drums, in particular those intended to contain noxious, toxic or dangerous products, said containers having to be water-soluble and biodegradable, characterised in that:

- it contains, as the base material, a polyvinyl alcohol with a sodium acetate concentration of at most 0.5 wt.% and a degree of hydrolysis of between 80% and 92%, said polyvinyl alcohol being supplemented by at least one plasticiser in the proportion of 13 wt.% to 20 wt.%, with respect to said composition;
- the moisture content of said homogenised thermoplastic composition, measured by the Karl Fischer method (standard NFT 20-052) is less than or equal to 0.5 % at 200°C and less than or equal to 0.1% at 120°C; and
- the concentration of non-molten material in said homogenised thermoplastic composition is such that, if said homogenised thermoplastic composition is used to form a film with a thickness of 100 μm, 10 m^2 of such a film will contain less than nine non-molten specks with sizes between 150 and 200 μm and will not contain any non-molten speck at all with a size greater than 200 μm.

20. A homogenised thermoplastic composition according to Claim 19 intended for the manufacture of said containers by using an extrusion blow-moulding process, characterised in that the melt flow index MFI, determined in accordance with the standard NFT 51-016, is between 1 and 10 g/10 min, at a temperature of 230°C, under the effect of a weight of 2.16 kg.

21. A homogenised thermoplastic composition according to Claim 20, characterised in that the viscosity at 20°C of the base polyvinyl alcohol, determined in accordance with

standards DIN 51-550 and DIN 1342, is between 8 and 40 mPa.s.

22. A homogenised thermoplastic composition according to Claim 21, characterised in that the viscosity at 20°C of the base polyvinyl alcohol, determined in accordance with standards DIN 51-550 and DIN 1342, is between 8 and 26 mPa.s.

23. A homogenised thermoplastic composition according to Claim 19 intended for the manufacture of said containers by using an injection moulding process, characterised in that the melt flow index MFI, determined in accordance with the standard NFT 51-016, is between 10 and 30 g/10 min, at a temperature of 190°C, under the effect of a weight of 2.16 kg.

24. A homogenised thermoplastic composition according to Claim 23, characterised in that the viscosity at 20°C of the base polyvinyl alcohol, determined in accordance with standards DIN 51-550 and DIN 1342, is between 3 and 8 mPa.s.

25. A homogenised thermoplastic composition according to Claim 24, characterised in that the viscosity at 20°C of the base polyvinyl alcohol, determined in accordance with standards DIN 51-550 and DIN 1342, is between 3 and 5 mPa.s.

26. A homogenised thermoplastic composition according to any one of Claims 19 to 25, characterised in that it is obtained from the intermediate thermoplastic composition specified in any one of Claims 13 to 18.

27. A water-soluble and biodegradable container, such as a bottle, flask or drum, in particular one intended to contain a noxious, toxic or dangerous product, characterised in that material of which it is composed is homogeneous and formed from said homogenised thermoplastic composition specified in any one of Claims 19 to 26.

28. A water-soluble and biodegradable container, such as a bottle, flask or drum, in particular one intended to contain a noxious, toxic or dangerous product, characterised in that it is made up of an external envelope and an adjacent internal

envelope and in that the material making up said internal envelope is formed from said homogenised thermoplastic composition specified in any one of Claims 19 to 26.

29. Use of the container specified in any one of Claims 27 or 28 for the storage and transport of a noxious, toxic or dangerous product, in particular a plant protection product, said product being useable after dissolution, suspension or dispersion in water, characterised in that said container is itself immersed in water after the contents have been removed.